Missouri Department of Conservation

Applying Research in Forestry

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Root Morphology Research from the Hardwood Nursery Cooperative

Bare-root seedlings need good shoot and root characteristics to survive and grow competitively in field plantations. Field plantings sometimes are considered successful when survival is high even though many seedlings do not grow rapidly enough to become part of the dominant or codominant stand. To offset this lack of competitive growth, landowners often plant more seedlings than necessary.

Most nursery seedling grading has concentrated on shoot characteristics with little attention to root systems. When shoot to root ratios have been considered, they traditionally have been based on the mass of roots without consideration for root morphology. This nursery cooperative project has concentrated on modifying cultural practices to improve the root morphology of red oak and black walnut seedlings.

Related work in this and other studies has shown that only the large (> 1 mm diameter) lateral roots on bare-root seedlings can withstand the rigors of lifting and storage. Smaller roots are lost to desiccation or physical damage. Most seedlings without a sufficient number of large lateral roots will either die or grow insufficiently when field planted. Healthy shoots can be produced in the nursery because of the optimal conditions there. However, seedlings with good shoots and poor roots respond poorly once planted in the field. The specific effort of this cooperative has been to determine the effects of undercutting, density control and seed source on the number of first order lateral roots > 1 mm in diameter produced on red oak and black walnut seedlings.

Undercutting is a practice that consists of drawing a blade horizontally through a nursery bed approximately 6 to 8 inches below the surface. This makes sense when you consider that walnut and red oak can produce taproots 18 to 24 inches long during the first growing season. When lifted, the seedlings are cut off at 10 to 12 inches below the surface thus losing half or more of the root system. Undercutting during the growing season, however, allows root systems to regenerate from 3 to 6 wound roots at or just above cut surfaces. Therefore, when undercut seedlings are lifted, they have an increased number of large first order lateral roots. In this study, half of the seedlings were undercut when a random sample of seedlings had taproots at a 6 inch depth of l/4 to l/2 inch in diameter.

Seedling growth is also affected by the density of the beds in which they grow. As bed density increases, diameter growth and root growth may be retarded, whereas height growth is either unaffected or increases. At some optimal density, shoot and root growth are balanced, and an adequate number of seedlings are produced. Density control in this study was achieved by thinning seedling beds to

Seedlings need a good root system to survive and grow competitively in plantations. Field results indicate that seedlings with more than 5 large lateral roots have greater survival and growth after two years. Use root characteristics to cull inferior seedlings with less than five lateral roots.

densities of 3, 6 and 9 seedlings per square foot.

As with observable traits, the number and size of roots produced on a seedling may be under fairly strong genetic control. Finding trees that produce seed encoded with the trait for many, large first order lateral roots would help in the production of superior seedlings. This study utilized several seed sources to determine if there was significant variation among families of seedlings in rooting characteristics. Large amounts of variation among families tells us that a trait is under genetic control.

Results

The study found that undercutting increased the number of lateral roots by thickening existing lateral roots and by stimulating new roots to be produced from the wounded zone. Timing is critical, especially with red oak. Top growth was also reduced providing a better root to shoot ratio (an abundance of roots with a moderate top). Diameter of the seedlings one inch above the root collar decreased slightly.

First order lateral roots > 1 mm decreased as the bed density increased. Decreasing seedling density to 3-6 seedlings per square foot resulted in the most large lateral roots for both red oak and walnut. The decreased densities also led to shorter, larger diameter seedlings, and thus better shoot to root ratios.

Family differences existed in the production of large lateral roots indicating genetic control over the trait. Improvement programs can focus on this trait as an early marker of superior seedling quality.

Early field results indicate that red oak seedlings with more than 5-6 large primary lateral roots and walnut seedlings with more than 8 have greater survival and growth after two years. There is a striking difference in the number of leaves (hence photosynthetic area) and stem caliper produced by these seedlings. Excavations have shown that the number of large lateral roots a seedling has when it is planted in the field are the number of roots it still has after two years. During the spring of 1991, demonstration plantings are being installed to show the effects of these nursery practices as well as some field practices (site preparation and planting method) on growth and survival.

Recommendations

These results can be used in the field for tree planting purposes. First, use root morphology characteristics to help you cull inferior seedlings. Try to plant only those seedlings that have greater than 5 large lateral roots. Second, some root pruning at the time of planting may be beneficial in that new wound roots will be created. Be sure not to cut off any large permanent lateral roots in the process, however. This may involve trimming the length of the larger lateral roots to 4 to 6 inches in length and trimming the tap root to an 8 inch length if there are no laterals coming directly out of this area.

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Mention of trade names is solely to identify materials used and does not imply endorsement by the Missouri Department of Conservation. Discussion of pesticides in this paper is not a recommendation of their use and does not imply that uses discussed here are registered.

Results and recommendations presented in this paper are preliminary but represent our best analysis at the present time. Please use this information with care.